

**REMARKS**

The applicants thank the Examiner for the thorough examination of the application. No new matter is believed to be added to the application by this amendment.

**Entry Of Amendment**

Entry of this Amendment under 37 C.F.R §1.116 is respectfully requested because it cancels claims and places the application in condition for allowance. Also, entry is proper because this amendment complies with matters of form set forth by the Examiner in the Office Action. Alternately, entry is requested because this Amendment places the application in better form by reducing issues for appeal.

**Status Of The Claims**

Upon entry of this Amendment, claims 1, 3-5, 8, 9, 11, 13-15, 18, 19 and 21 are pending in this application. Claims 6, 7, 10, 12, 16, 17 and 20 are cancelled by this amendment. Support for the amendments to claim 1 can be found at page 3, lines 18-19, page 7, lines 15-23 and page 12, lines 14-16 of the specification. Support for the amendments to claims 11 and 21 can be found at page 10, line 21 to page 11, line 2 of the specification. Support for the amendments to claim 13 can be found at page 9, lines 15-16, page 7, line 16 and at page 12, lines 14-16 of the specification.

**Claim Objections (page 2 of the Office Action)**

The Examiner objects to the wording of claim 1. The Examiner's comments have been considered. Claim 1 has been amended to reflect the Examiner's suggestion.

The Examiner objects to claims 11 and 21 as containing the term "type." Claims 11 and 21 have been amended to remove this term.

**Rejections Under 35 U.S.C. §112 (pages 2-3 of the Office Action)**

Claim 12 is rejected under 35 U.S.C. §112, first paragraph as not being enabled by the specification. Claim 12 is rejected under 35 U.S.C. §112, second paragraph as being indefinite. Claim 12 is cancelled by this amendment, thereby rendering these rejections moot.

**Rejection Under 35 U.S.C. §102(b) Over Bass (page 4 of the Office Action)**

Claims 1, 3-6, 8-16 and 18-21 are rejected under 35 U.S.C. §102(b) as being anticipated by Bass (U.S. Patent 6,001,500). Applicants respectfully traverse.

**The Present Invention And Its Advantages**

The present invention pertains to a novel flexible fuel cell suitable for utilization in compact portable devices such as mobile phones, video cameras, notebook-type personal computers, i-pods, etc. Achieving this purpose, in

part, is facilitated by using methanol as fuel because methanol affords safe and easy handling even when the invention is used in portable devices.

The present invention finds a typical embodiment in instant claim 1:

**1.** A fuel cell, comprising a tubular polymer electrolyte membrane, with a fuel electrode on an inner side of the membrane, and with an air electrode on an outer side of the membrane,  
wherein at least one of the fuel electrode and the air electrode is composed of a carbon particle material on the surface of which catalyst fine-particulates are dispersed and loaded,  
wherein the polymer electrolyte membrane prevents fuel on the inner side of the membrane from leaking, and  
wherein methanol is used as the fuel, and  
wherein the fuel cell is flexible to be accommodated to an apparatus and operates at a temperature to cause output of electric power at 100°C or less.

Features of the present invention, in part, reside in:

- (i) a fuel cell formed from a tubular polymer electrolyte membrane,
- (ii) a fuel electrode being present on an inner side of the membrane,
- (iii) at least one of the fuel electrode and the air electrode being composed of carbon particle material on the surface of which catalyst fine particles are dispersed and loaded,
- (iv) the polymer electrolyte membrane preventing fuel on the inner side of the membrane from leaking,
- (v) methanol being used as fuel, and
- (vi) the fuel cell being flexible to be accommodated to an apparatus and being able to operate to output electric power at 100°C or even less.

As mentioned above, methanol is used as fuel. In contrast, conventional hydrogen fuel presents hazards that fail to satisfy the requirements fulfilled by the invention. That is, hydrogen is not suitable for use in portable devices because the hydrogen technology generally requires a high gas pressure during operation. Also, a bulky reformer is required in the vicinity of the hydrogen cell.

In contrast, the invention is directed at a fuel cell that is suitable for portable devices. Portable devices have numerous electric parts such as a circuit board, wiring, a power source, etc. These parts are integrated and packed into a restricted space to form the compact body of the portable device. Particularly, a power source is one of the essential parts of every device. Conventional power sources have a large size and fixed shape. To solve these problems, the inventors developed a novel fuel cell construction that combines miniaturization with flexibility. The inventive flexible fuel cell can respond or conform to changes, i.e., bend repeatedly. As a result, the invention can accommodate the limited space found in portable electronic devices.

*Distinctions Of The Invention Over Bass*

Bass pertains to a cylindrical membrane fuel cell that uses hydrogen as fuel (claim 1). Bass fails to disclose or suggest a low-temperature, flexible fuel cell technology that uses methanol, much less a fuel cell structure that provides safety and easy handling.

Bass is directed at a fuel cell having durable construction for use in transport (vehicle) applications. For this purpose, Bass's fuel cell requires a solid construction in order to protect the fuel cell from mechanical failures (see Bass at column 1, lines 15-46). Bass therefore employs solid materials such as a carbon rod and stainless steel to which a polymer electrolyte membrane is tightly fitted.

The solid construction of the fuel cell of Bass can be better understood by considering the operating conditions. Bass's fuel cell generates heat and reaches a temperature of 200°C or more (see Bass at Table 1 at column 9). For cooling, a large volume of airflow is introduced into Bass's fuel cell (see Bass at column 9, lines 64-65). Accordingly, a solid construction is required to sustain the pressure of the airflow, and such a device would never be practical for installation in the mobile electronics (such as mobile phones).

In contrast, the fuel cell of the invention can be operated at a temperature of 100°C or even less without resorting to any cooling means.

The solid construction of the fuel cell of Bass can be further understood from the fuel cell's preparation method. Bass first soaks the polymer membrane in methanol. Then, the swelled polymer is attached to a carbon rod and shrink fitted by drying. As a result, the polymer is shrunk tightly in place (see Bass at column 7, lines 21-28). Solid materials are thus consequently required in order to maintain this geometry. In this regard, Bass emphasizes that the solid construction is advantageous (see Bass at column 6, lines 49-49,

stating that “substantially solid structure is advantageous because it can avoid the need for bulky end plates.”). Therefore, a solid structure is a requirement for the technology of Bass.

In contrast, the invention necessarily requires a flexible structure to fulfill its purpose. A polymer electrolyte membrane (not soaked) is first prepared, and the surface thereof is provided with carbon particles and the like to prepare the desired flexible fuel cell. Such a flexible fuel cell is first attained by using the structure of claims 1 or 13 with a methanol fuel.

As a result, Bass fails to anticipate or suggest many of the claimed features set forth in claims 1 and 13 of the invention, such as flexibility, methanol fuel and low operating temperature. Claims depending upon claims 1 and 13 are patentable for at least the above reasons. This rejection is overcome and withdrawal thereof is respectfully requested.

**Rejection Under 35 U.S.C. §102(b) Over Muthuswamy (pages 4-5 of the Office Action)**

Claims 13, 14, 16-18, 20 and 21 are rejected under 35 U.S.C. §102(b) as being anticipated by Muthuswamy (U.S. Patent 6,060,188). Applicants respectfully traverse.

The present invention and its advantages have been discussed above.

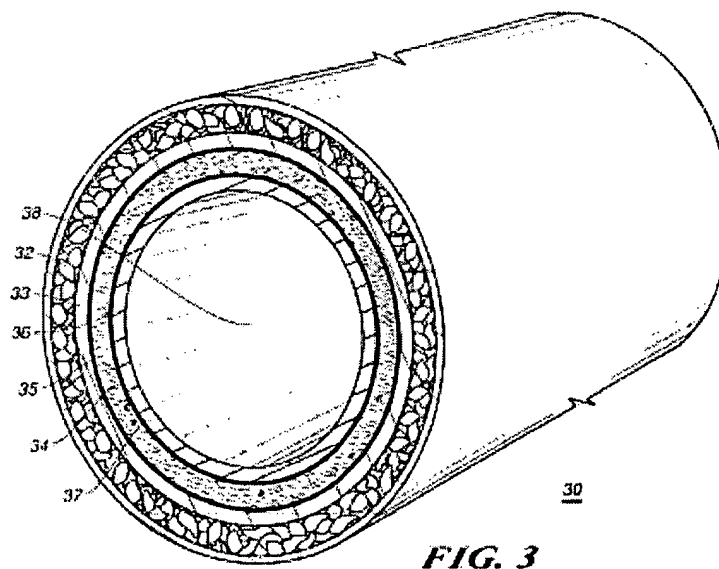
Muthuswamy pertains to a high-pressure fuel cell that employs a “stiff and rigid central core” (see Muthuswamy at column 4, line 11). This rigidity is required because Muthuswamy aims at a fuel cell that can operate at high

pressures (see Muthuswamy at column 5, lines 22-23). As a result, it is clear that the fuel cell of Muthuswamy has a solid construction.

Also, Muthuswamy aims at automated fabrication of a fuel cell of continuous length (see Muthuswamy at column 5, lines 16-18). To this end, Muthuswamy adopts a solid material to make up a stiff and rigid central core to improve the manufacturing efficiency.

In contrast, the invention is drawn to a flexible fuel cell that is fundamentally different from Muthuswamy.

However, the Examiner asserts that one of the embodiments of Muthuswamy does not have a central core but teaches a hollow chamber (see Figure 3 of Muthuswamy, which is reproduced below).



This fuel cell of Muthuswamy does not have a central core. However, a cylindrical component 32 is composed of a solid material such as a reticulated vitreous metal. Muthuswamy at column 4, lines 49-50 describes this material

as providing "a rigidizing function to the entire structure." Further, Muthuswamy teaches that one primary advantage of this cylindrical component 32 is its rigidity and ability to provide a solid base around which the fuel cell can be built (see Muthuswamy at column 3, lines 18-20). This description explicitly demonstrates that the fuel cell of Muthuswamy has a solid construction as well as having a solid rigid cylindrical core.

In contrast, the invention is flexible so it can be accommodated to an apparatus (see claims 1 and 13). As a result, Muthuswamy not only fails to anticipate the invention, but also fails to suggest the invention to one seeking a flexible fuel cell technology. Muthuswamy therefore fails to anticipate claim 13, and claims depending upon claim 13 are patentable for at least the above reasons.

This rejection is overcome and withdrawal thereof is respectfully requested.

**Rejections Under 35 U.S.C. §103(a) Over Bass And Muthuswamy (pages 5-6 of the Office Action)**

Claims 7 and 17 (whose subject matter has been incorporated into claims 1 and 13, respectively) are rejected under 35 U.S.C. §103(a) as being obvious over the combination of Bass with Muthuswamy. Applicants respectfully traverse.

The invention, Bass and Muthuswamy have been discuss above, and these discussions are not reproduced here at length for the sake of brevity.

As discussed above, the present invention has unique flexibility that arises from its novel construction. The fuel cell of the invention can be almost freely bent to accommodate the shape of the electronic apparatus without damaging the output of electric power. Further, the inventive fuel cell operates at low temperature using methanol as fuel, thereby securing safe and easy operation in portable devices.

In contrast, Bass aims at improving the durability of a fuel cell that is operating using hydrogen gas. Muthuswamy aims a high-pressure operation. Neither Bass nor Muthuswamy disclose or suggest the flexible, methanol-fueled fuel cell of the invention. Indeed, both references emphasize rigid construction as being advantageous, and thus the cited art teaches away from the flexible fuel cell of the invention.

As a result, one having ordinary skill in the art would not be motivated by the combination of Bass with Muthuswamy to produce the inventive methanol-fueled flexible fuel cell of independent claims 1 and 13. A *prima facie* case of obviousness has thus not been made. Claims depending upon claims 1 and 13 are patentable for at least the above reasons.

Further, even if one assumes *arguendo* that a *prima facie* case of obviousness could be made, this obviousness would be fully rebutted by unexpected results. These unexpected results include the low temperature operation discussed at page 12 of the specification (and claimed in claims 1 and 13). In contrast, Bass at Table 1 (column 9) has operating temperatures at

about 200°C. Also, the invention shows superior current-potential characteristics and current-power characteristics, as are set forth in Figures 3(a), 3(b), 4(a) and (4b). The advantages of the invention are thus clear.

This rejection is overcome and withdrawal thereof is respectfully requested.

### **Conclusion**

Thus, with the above remarks and amendments, Applicants believe that the claims, as they now stand, define patentable subject matter such that passage of the instant invention to allowance is warranted. A Notice to that effect is earnestly solicited.


If any questions remain regarding the above matters, please contact Applicant's representative, Robert E. Goozner, Ph.D. (Reg. No. 42,593), in the Washington metropolitan area at the phone number listed below.

Pursuant to 37 C.F.R. §§ 1.17 and 1.136(a), Applicant(s) respectfully petition(s) for a two (2) month extension of time for filing a reply in connection with the present application, and the required fee of \$450.00 is attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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